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Bożena Witek, Peter Liedke

Is contemporary food safe?

Nutrition

Human nutrition is a phenomenon as old as the history of *Homo sapiens*. Getting food, its production, and consumption have always been one of the most important human activities and human tasks, and any failure, in this regard, has had important biological and social implications. Nutrition appears to be the requirement of the existence of every living organism and food tends to be one of the most powerful environmental factors that influence organisms (Ponzoni et al. 2009). Organic substances in the form of carbohydrates, fats, and proteins extracted from food are used by the organism to protect and satisfy its energy needs associated with performing the psychomotor activity (Yamada 2008). Specific food products provide, in the appropriate proportions and nutritional values, various nutrients, e.g. higher nutritional value of the protein derived from milk, meat or fish, in comparison to the protein derived from groats, flour, or leguminous plants (Bregendahl et al. 2002). The presence of all nutrients in the diet is crucial since every nutrient performs different specific function. Therefore, a deficiency, or absence of any of them can cause problems with the absorption disorders of another element, e.g. the use of iron in the daily food ration is worse if there is the deficiency of vitamin C in the organism (Atanassova, Tzatchev 2008; Saito 2009).

Human nutrition is one of the basic conditions not only of human life as such, but also human development, health, and physical fitness, as well as the source of human satisfaction so as to meet all human needs in all aspects of life. Thus, the food, or should it be said, a perfectly composed diet plays an essential role in maintaining the body in health and vitality, moreover, it is important to prevent the organism from contracting diseases. To keep the body in good health, the education dealing with the principles of appropriate nutrition is needed to be introduced. Due to such knowledge, the proper information can be acquired in the subject of the type, quantity, functions and the location of particular nutrients, which should be provided to the body with daily food rations (Freedman et al. 2001).

However, 'is it enough to know what products and in what quantities should be eaten so as to be healthy?' Is it also important to know the source of the food we eat? What methods and technologies were used to produce food? What were the conditions of transportation, namely, what temperature was used during the transport and how long it took? And finally, what were the conditions of food storage?

Answering these and many other questions concerning the quality of food products will allow us to find the answer to the question formed in the title of the article, namely, 'Is contemporary food safe for humans?'

Nevertheless, first of all, we shall deal with some history...

The impact of the optimal diet and the proper nutrition on human health and the length of human life was already known in ancient times. It can be proven by providing the words of the philosopher and doctor [physician] of that time, namely Hippocrates, 'Let food be thy medicine and medicine be thy food'. According to the views of Hippocrates, the rational nutrition was also associated with combining foods that had moisturizing effects and drying effects in meals (Glatzel 1967). In the ancient Greece and Rome, the rational nutrition was based on the theory of the four elements, which meant composing meals consisting of foods with different flavours. The particular diet was mainly created due to the 'natural' environment, in which the human lived. In the so-called naturalistic period lasting from about 400 BC to about 1750, there was no scientific knowledge concerning nutrition. Aulus Cornelius Celsus, a Roman scholar who lived 25 BC – 50 AD, believed that food was composed of just one nutrient known as the so-called 'matter'. Human nutrition, generally speaking, regardless of age, sex, and the state of health, was based on the eating habits, traditions, beliefs, superstitions, and religion. It is not surprising, though, that during this period a number of diseases was common, i.e. scurvy, rickets and nyctalopia (also known as 'night blindness'). The eleventh century was the beginning of the introduction of the nutritional recommendations, which required combining products in the diet from groups of different [proven] impact on human health. Such state had lasted until the mid – eighteenth century when Antoine Lavoisier, a French physicist and chemist, who was considered to be the father of the science of human nutrition, showed that food, after the consumption, was combusted in human and animal bodies in the presence of oxygen together with giving off the energy (Madeira 2012).

The German physiologist, Max Rubner, continuing Lavoisier's research calculated how much energy was given off during the combustion of one gram of fat, carbohydrates, and proteins. Rubner was also the person to discover that organisms with slower metabolism were considered to be long-lived ones. His discovery was identical to the results of Max Kleiber, a Swiss biologist, according to which the metabolic rate and lifespan of animals depended on their body weights, as well as that large animals did not only have a slower metabolism, but also lived longer. The nineteenth century and the early twentieth century was the time period during which the issues of identifying and acknowledging basic nutrients, and the consequences

of their deficiencies in the diet were mainly dealt with. However, at that time, their components, such as: fatty acids, amino acids, and dietary fibre (also known as: roughage, or ruffage) were not paid attention to.

Over the centuries, in the field of science, substantial evidence was given to confirm the close relation between the consumed food, the state of health and the length of human life. Despite numerous discoveries in that period of time, also associated with the development of the science of nutrition, the changes and progress in this area were insignificant.

At the end of the nineteenth century, noticeable improvements were observed in many disciplines of science, namely, Biology, Chemistry, Physics, and Medicine. Then, four nutrients, i.e. proteins, carbohydrates, fats, and dietary minerals were to be distinguished. The work on the composition and nutritional value of products was initiated, moreover, the nutritional standards, which already took into consideration the age, gender, and physical activity, were developed. The researchers of that period not only described the structure and functions of proteins, but also their amino acid composition, the importance of fats and fatty acids, the discovery of new nutrients, the fact of determining the nutritional value of products, developing nutritional standards, and many other issues. Finally, vitamins were discovered. This scientific event happened due to the Polish biochemist – Kazimierz Funk; furthermore, he also introduced the term 'vitamin'. This researcher not only discovered many vitamins, including thiamine (vitamin B1), but also treated patients with the vitamin deficiency, and was able to predict that the lack of vitamins could cause diseases (Piro et al. 2010).

The scientific and technological progress, which made it possible for the food intake to be independent of time and place of its consumption, was an important factor that had a significant impact on the human diet. Therefore, the cultivation was enriched by new species of plants, moreover, the work on new species of animals and fish was carried out. The fact of making scientific developments common, including those related to nutrition, and the development of biotechnology, as well as genetic engineering, led to significant changes in the lifestyle and diet; unfortunately, they were not always beneficial to the individual. At the same time, consumers became more interested in not only maintaining good health, but also preventing themselves from the aging processes.

The modern food consumer is aware of the fact that even the most valuable products consumed inexcusably, or in the wrong composition of other products can be harmful to the organism. It means that it can be both inappropriate and even dangerous to have the deficiency of proteins, as well as an excessive amount of them. The protein deficiency can be observed among e.g. the elderly people, people on special diets, including vegetarians, as well as some sportspeople, such as bodybuilders (Rutherfurd-Markwick 2012). The risk of the excessive amount of protein presence is associated with an excessive burden on kidneys and the liver, the risk of arteriosclerotic vascular disease, also called ASVD (atherosclerosis),

osteoporosis, and joint disorder (arthritis). The result of inappropriate nutrition, apart from the diseases mentioned above, can also appear in the form of diabetes – type 2, known as adult-onset diabetes (diabetes mellitus type 2), gallstones (cholelithiasis), cancer, and obesity (Desai et al. 2013; Kennedy et al. 2001), which is understood as the pathological accumulation of fat tissues in excessive amounts, namely, physiologically and adaptability more than needed by the organism can cause diseases, such as: high blood pressure – HTN (arterial hypertension), diabetes mellitus type 2, pulmonary embolism – PE (lung embolism), and degeneration of the spine (spinal spondylosis). Globally speaking, among the health risks caused by deficiencies, the deficiency of vitamin A, iodine and iron appear to be particularly concerning (Sommer and Vyas 2012). However, such kinds of 'risks' associated with the excessive or deficient amounts of certain nutrients, are more likely to be observed due to the individual, in a way voluntary, behaviours…

Asking about the issues, such as: 'Is the contemporary food healthy?' and 'Is the contemporary food safe?' people want to know if after the consumption of food offered by the chain of stores, they will be at risk other than 'the one' possibly related to the excessive or deficient amounts of nutrients (Hornig and Walter 2004). According to the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO), the so-called. 'safe food' does not cause negative health effects in the organism. However, 'Can the harmful effect of food on the human organism be allowed at all?' It cannot, unless it is not intended (FAO/WHO 2002; WHO 2003).

The term 'food' means the substances, or the processed products, partially processed products, or unprocessed products (whole foods) intended to be consumed by humans, or the ones which can be expected to be consumed by people. The food classification is primarily based on the process of its preparation/production. While choosing the type of food one should not only be interested in its nutritional value but also in the information providing the knowledge how it was produced, transported, and stored. It seems that the most beneficial to human health is the food that is unprocessed or processed to an insignificant extent. Taking into account the methods of food preparation/production, the following kinds can be specified, namely, conventional food, ecological food (bio food, and organic food), genetically modified food (GM food), and other types of foods that combine the features and characteristics of conventional food, ecological food, and genetically modified food. Such types of foods involve e.g. convenience food, functional food, or new food. Functional food, according to its composition, is divided into the following kinds: enriched (e.g. in antioxidants, vitamins, dietary fibre), low energy, high dietary fibre, probiotic (enriched in live cultures of bacteria), low sodium, low cholesterolemic, energizing. The so-called 'attribute food' tends to be an interesting category of food, which specifies the food products with the exceptional fool qualities preferred by particular groups of consumers. This type of food combines the features of ecological food, vegetarian food and kosher food.

Conventional food

The food products produced by the use of the conventional methods are widely available on the market. The raw ingredients for its production are provided by conventional farming (agriculture), which allows the use of mineral fertilizers, crop protection chemicals, agricultural chemicals that stimulate weight gaining of the produced plants, and animal breeding. The methods of the production employed in conventional farming enable reaching the production goals, however, the unnatural application of environmental sources by the use of crop protection chemicals, artificial fertilizers and animal feeding stuffs causes the extinction of wild birds and animals, as well as environmental degradation. The conventional technologies are not only a sign of elimination of certain characteristics of the raw ingredients, but also of the artificial enrichment in other specific properties by the use of genetic modification. More and more frequently the effects of the conventional production appear to be negative, and they result in Bovine Spongiform Encephalopathy (BSE) found in animal and poultry kinds of meat since such meat tends to contain hormones or dioxins, moreover, mercury can be found in fish. The risk of appearing of a particular disease due to the consumption of products that are not safe depends on the individual human genetic predisposition. The chemicals added to conventional foods are permitted for consumption within certain declared standards and norms. The healthy human body can easily cope with small amounts of such substances, however, their systematic introduction to the body by their consumption is believed to be an important factor in the range of initiating health risks (von Götz 2010).

The society today has to face the necessity of the ecological and civilization compromise, which could combine the technological advances in the food production with the need to make everyday life easier, together with the food safety, and the concern for natural environment. On the one hand, modern technologies used in food processing make it more long-lasting, tastier, and easier to prepare for the consumption. On the other hand, to meet the requirements of the consumer, food producers intentionally enrich it by the use of various substances, such as: food colouring (colour additives), preservatives, emulsifiers (emulgents), smelling essences (aroma substances), flavour enhancers, artificial sweeteners (sugar substitutes), raising agents (bulking agents), firming agents (stabilizers), which are of no nutritive character. More recently, in Poland the authorized list of such substances has increased to almost 290 of them.

The production of such food would not be possible without the use of the conventional agriculture plant protection chemicals (which are taken to protect cultivated plants against diseases and pests) the synthetic fertilizers, and the veterinary medicine. Conventional food can also be the source of contamination occurring accidentally. The so-called impurity, being the result of the contamination, can be understood as any substance that is not intentionally added to the food during its production process, or as a consequence of the environmental pollution. Therefore, the food can contain heavy metals, pests, toxins, microorganisms, chemicals from

food packaging, the remains of crop protection chemicals, synthetic fertilizers, and technical contamination. Furthermore, due to unskilful use of the technological processes associated with food processing, chemicals used for cleaning, or insufficient way of their removing, they can become the source of accidental contamination. All above mentioned substances can cause potential risks to human health. Their impact on human health can be manifested in various ways, depending on their type, their quantity, properties, and the way [method] of how the contaminants can penetrate the body (Hulme 2013).

A completely separate category of food contaminants is constituted as biological contaminants. The bacterial food poisoning phenomena seem to be the greatest threat to human health and life, and are the subject of the special attention drawn by sanitary and veterinary services. According to the existing Polish law, to be precise (the Act No 63 item 634 from May 11 2001), the presence of contaminants in food products, such as: microorganisms, pests, toxins, mould or other chemicals, makes it unsuitable for consumption.

One of the most dangerous kinds of bacteria that is responsible for food poisoning tends to be recognized as *Salmonella*, which causes the poisoning called *Salmonellosis* developed by the animal *Salmonella* type of bacteria. Another reason of food poisoning can be referred to the bacteria which can develop in the food, and/or in the human body, not to mention the environment. It is worth paying attention to, especially, E. coli (*Escherichia coli*), which can develop in the human body, and Streptococcus (*Streptococcus faecalis*) found in the excrement (faeces). The pathogenicity of bacteria is determined by their invasiveness, namely, the ability to penetrate the tissue, and to spread, as well as their toxicity, i.e. the ability to produce toxins.

Together with the increase in the public awareness, the interest in the wholesome food, free from contaminants including those accidental ones seems to be expressed. It occurs that such requirements can be met by ecological food, also specified as bio food, organic food and/or natural food. Ecological food is considered to be the food that has the nutritional value similar to conventional food, nevertheless, it is more friendly to the human body and the environment in which people live.

Ecological food

Ecological food refers to plant and animal products made (produced) by using natural means of production, without synthetic additives, and chemical contaminants, moreover, free from chemical fertilizers, preservatives, antibiotics, hormones, not genetically modified, and not subject to radiation. Standards and norms related to the production, processing, transportation, packaging and storage of ecological food are very strict at all stages of the process. The whole process of the plant growth and animal breeding is carried out in a natural way. Such products are produced in accordance with the principle of the sustainable use of the renewable resources, taking care of the quality of the environment, as well as maintaining the

genetic diversity of plants and animals. Ecological food is produced by the use of only carefully selected ingredients /components, thus, the organic fruit, vegetables and meat should not contain even the insignificant amounts of artificial fertilizers, pesticides, and veterinary specifics.

Producing, processing, and storing ecological food according to the particularly determined requirements, by the use of special biological, mechanical, physical, enzymatic, fermenting, and microbiological technologies and methods, allow producers of ecological food to take action so as to get the certificate of the ecological food producers. The system of inspections and certification is the key component of organic agriculture (ecological farming) functioning. The inspection and control procedure refers to all who initiate the production and processing by using ecological methods and the food safety, which obviously, is guaranteed by the certificate confirming the product to be the ecological one. The violation of the environmental standards and norms by the producer causes the withdrawal of the certificate even for several years.

The advantage of ecological food is that it does not contain preservatives. More values of ecological food can be found in the high content of antioxidants (including vitamin C and polyphenols), which can lower the blood pressure, reduce the risk of heart diseases and strokes, improve the natural defence mechanisms of cells indicating the strong anti-cancer activity. Ecological food contains the increased amounts of magnesium, phosphorus, calcium, iron, beta-carotene (especially, in tomatoes, peppers, carrots, pumpkins). In comparison to conventional food, such food contains only minimal amounts of pesticides. Moreover, vegetables and fruit production with organic farming methods compared to vegetables production with conventional methods has a low amount of nitrate due to the fact that they contain a lower amount of water, which apart from the health benefits (values) make their pace of decomposing understood as rotting (decay) slower.

Genetically Modified food (GM food)

Genetic modification of organisms by the way of spontaneous mutation has been taking place since the beginning of life on Earth. Nevertheless, it is the human being who has been always intervening in the genetic material of organisms by, e.g. the use of the genetic operations, namely, crossover (also known as: recombination), which means the programming of a chromosome or chromosomes from different individuals, furthermore, of looking for new, not always favourable characteristics of plants and animals. The first significant changes in this area of activities began after the domestication of plants by humans who by using genetic operation, i.e. crossover and selection processes, took responsibility for exchanging the genes between closely related species. The new variation appearing as the result was used in the traditional plant growing.

As the turning point for such activities people can consider the year 1953, when an American geneticist – James Dewey Watson, an English biochemist – Francis

Harry Compton Crick, and a British biologist - Rosalind Elsie Franklin developed a spatial model of the construction of deoxyribonucleic acid (DNA) and described its properties. However, to reveal the practical use of their findings, the world had to wait a little longer.

Acknowledging and understanding the basics of genes functioning enabled their various modifications, changes in their activity, moving them to species of different kinds, or introduction of additional copies of their own genes. The genetic manipulation allows connecting a plant's genes with another plant's genes, as well as with animal genes, moreover, it allows connecting animal genes with human genes. Nowadays, the methods used in biotechnology enable creating the plant organisms with the characteristics desired by the producer, or researcher; among other things, they involve better characteristics of their use, resistance to diseases (viral, bacterial, and fungal infections), resistance to pests, a better quality of determined characteristics in relation to previous variations, as well as getting new gene sets of plants that would not crossover with others in their natural environment. The genetic modification of plants is also designed to increase the tolerance to abiotic stress, extend the life of fruit and vegetables, moreover, to improve their flavour, to change the composition of fatty acids and amino acids, and to increase the amount of crops. Globally, and in Europe, there are some plants that tend to be most frequently modified and they involve: corn, tomatoes, soybeans, potatoes, cotton, melons, tobacco, Canola – Rapeseed (*Brassica napus)* and sugar beet.

The aim of the genetic modification of animals is to accelerate the pace of growing by including the additional gene of the growth hormone (pigs, fish, poultry), to increase milk production (cattle), and egg laying (hens), to improve the quality of meat, or to help strong immunity system to develop so as to prevent it from certain diseases by the introduction of resistance genes (gene providing sufficient defences in the piglet's organism).

However, the main purpose of the world food producers of the genetically modified food is to satisfy the growing needs for food in the constantly increasing human population, to reduce the damage caused during the transportation and the storage of food, as well as the production of products with high nutritional values. Therefore, the question arises as to whether such food producers do all these things for the consumers (Sparrow 2009).

Functional food

The concept of functional food is derived from the philosophical tradition of the East, where there is no clear distinction between medicine (drugs) and food. The research dealing with functional food started in the 1980s in Japan, and just after several years the appropriate legislation was introduced. For that reason, its production on an industrial scale started. Therefore, Japan is the only country in which functional food has its own legal status and the significant place on the food market. The Japanese were the first people in the world to define this type of food.

According to the definition suggested by them, it is the food for the specified health use (FOSHU, Food for Special Health Uses).

In 1996 in Europe, the research programme called Functional Food Science started (FUFOSE) and it was funded by the European Commission. According to the FUFOSE report from 1999, "food can be considered functional if it has been proven beneficial, i.e. it has more than the nutritional effect that can influence one or more functions of the organism" and such influence has to rely on improving the state of health and well-being, not to mention, on reducing the risk of diseases.

Functional food is defined as the food designed for the specific needs of the organism. Functional food in the traditional form is usually produced by conventional methods, however, raw ingredients for its production are received from special breeding and cultivation, or from the specially selected livestock, including genetically modified ones. Its beneficial effects on health should be proven and documented by the clinical studies conducted on humans whose diets contained the tested food product. Only scientifically proven health benefits of such product can enable its acknowledgement as functional food.

To produce functional food, the bioactive components, such as: dietary fibre, oligosaccharides, amino acids, peptides, proteins, polyunsaturated fatty acids, vitamins, minerals, choline, and lecithin, live culture of bacteria should be used. Functional food can also be produced by the technological modification relying on the elimination of undesirable components, such as: fat, cholesterol, salt or sugar, as well as their substitutes (Young 2003). Consequently, the offer of functional food includes food products which are: enriched, low energy, high dietary fibre, probiotic, low sodium low cholesterolemic, and energizing (Weiss et al. 2006). Due to the possibility of meeting the specific needs of the organism by functional food products, the following products are distinguished: for people coping with stress, wanting to reduce the risk of cardiovascular disease, cancers, osteoporosis; that could inhibit the aging process; dietary ones for people with the metabolism and digestive disorders; for sportspeople; for the elderly people; as well as the ones that influence psychomotor efficiency.

Summarizing, it is not easy and it is not always possible to find the reliable answer to the question asked in the introduction, i.e. "Is contemporary food safe?" The food safety is built as a result of a number of thoughtfully concerted actions taken at every stage of its production, processing, storage, and distribution in order to eliminate the hazardous situations, or reduce the risk to the minimum. The consumers' views and the views of the food experts differ in evaluating food safety. The consumers believe that the greatest threat to human health can be found in food with the presence of the added substances, known as preservatives. According to the FAO, the greatest risk is associated with the presence of microorganisms, such as: *Salmonella* and some rare strains of *Escherichia coli*. In accordance with the appropriate procedures introduced for the safety evaluation, all food additives are subject to rigorous estimation. The food producers are required to provide the consumers

with the precise information on the properties of the product. If any doubts about food safety occur, further testing should be organized, and only when the product receives positive test results, can it be re-approved for the consumption. In the case of food, however, it is not always possible to get the risk level at the lowest rate. One of the numerous ways of getting the safety level tends to be strict reference of the consumer to the recommendations of the producer, taking into account the storage, and the preparation of the products bought. In case of any concerns about the quality of a particular product, questions should be asked about the source of its origin, its nutritional value, the methods of its production, the conditions of its transport and the storage, as well as about the research results [certificates, tests] carried out in order to prove its safety.

Therefore, the appropriate answer to the question – 'Is contemporary food safe?' depends exclusively on the consumer…

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Is contemporary food safe?

Abstract

Food and water are necessary to keep the human body functioning. People must have a balanced diet that includes a complex range of nutrients to provide energy, maintain health and resist disease. For a long time researchers have discussed the differences between conventional, ecological (organic) and genetically modified (bioengineered) food.
The difference between these food systems is in the production. Ecological products must be produced according to European regulations for ecological food, without synthetic fertilizers, irradiation, and chemical additions to food. Genetically modified foods are foods that have had a gene from a different species of plant or other organism introduced to produce the desired characteristics or traits. Bioengineering can also be used to increase the nutrient content of foods, or to add vitamins that are not found in food. The conventional food production means first of all maximizing the efficiency, increasing overall production and lowering the price for the consumer. Many researchers believe that there is no evidence that ecological food is safer, more nutritious than conventional and modified food. The discussion about safety of contemporary foods continues.

Key words: nutrition, food, GMO, safety

Bożena Witek
Jan Kochanowski University in Kielce, Poland

Peter Liedke
2Legal Advisory and Social Care, Braunschweig, Germany